

## Chapter 48: Urinary Tract Infections

### INTRODUCTION

- Definition: A *urinary tract infection* (UTI) is defined as the presence of microorganisms in the urine that cannot be accounted for by contamination.
- Lower tract infections include cystitis (bladder), urethritis (urethra), prostatitis (prostate gland), and epididymitis. Upper tract infections involve the kidney and are referred to as *pyelonephritis*.
- *Uncomplicated* UTIs are not associated with structural or functional abnormalities that may interfere with the normal flow of urine or the voiding mechanism. *Complicated* UTIs are the result of a predisposing lesion of the urinary tract, such as a congenital abnormality or distortion of the urinary tract, stone, indwelling catheter, prostatic hypertrophy, obstruction, or neurologic deficit, that interferes with the normal flow of urine and urinary tract defenses.
- *Recurrent* UTIs, two or more UTIs occurring within 6 months or three or more within 1 year, are characterized by multiple symptomatic episodes with asymptomatic periods occurring between these episodes. These infections are due to reinfection or relapse. Reinfections are caused by a different organism and account for the majority of recurrent UTIs. Relapse represents the development of repeated infections caused by the same initial organism.
- The most common cause of uncomplicated UTIs is *Escherichia coli*, accounting for more than 80%–90% of community-acquired infections. Additional causative organisms are *Staphylococcus saprophyticus*, *Klebsiella pneumoniae*, *Proteus* spp., *Pseudomonas aeruginosa*, and *Enterococcus* spp.
- The urinary pathogens in complicated or nosocomial infections may include *E. coli*, which accounts for less than 50% of these infections, *Proteus* spp., *K. pneumoniae*, *Enterobacter* spp., *P. aeruginosa*, staphylococci, and enterococci.

### CLINICAL PRESENTATION

- The typical signs and symptoms of UTIs are:
  - ✓ Lower UTI: Dysuria, urgency, frequency, nocturia, suprapubic heaviness, and gross hematuria.
  - ✓ Upper UTI: Flank pain, fever, nausea, vomiting, malaise, and costovertebral tenderness.
- Symptoms alone are unreliable for the diagnosis of bacterial UTIs. The key to the diagnosis of a UTI is the ability to demonstrate significant numbers of microorganisms present in an appropriate urine specimen to distinguish contamination from infection.
- Older patients frequently do not experience specific urinary symptoms, but they will present with altered mental status, change in eating habits, or gastrointestinal symptoms.
- Examination of the urine is the cornerstone of laboratory evaluation for UTIs. Microscopic examination of the urine should be performed by preparation of a Gram stain of unspun or centrifuged urine. The presence of at least one organism per oil-immersion field in a properly collected uncentrifuged specimen correlates with greater than 100,000 colony-forming units (CFU)/mL ( $10^5$  CFU/mL [ $>10^8$  CFU/L]) of urine.
- A quantitative count of  $10^5$  CFU/mL ( $10^8$  CFU/L) or more is considered indicative of a UTI; however, up to 50% of females will present with clinical symptoms of a UTI with lower counts ( $10^3$  CFU/mL [ $10^6$  CFU/L]).



- The presence of pyuria ( $>10$  white blood cells [WBC]/ $\text{mm}^3$  [ $10 \times 10^6/\text{L}$ ]) in a symptomatic patient correlates with significant bacteriuria. A count of  $5\text{--}10$  WBC/ $\text{mm}^3$  ( $5 \times 10^6\text{--}10 \times 10^6/\text{L}$ ) is accepted as the upper limit of normal. Hematuria, microscopic or gross, is frequently present in patients with UTI, but is nonspecific.
- The nitrite test can be used to detect the presence of nitrate-reducing bacteria in the urine (eg, *E. coli*). The leukocyte esterase test is a rapid dipstick test to detect pyuria.
- The most reliable method of diagnosing UTIs is by quantitative urine culture. Patients with infection usually have more than  $10^5$  bacteria/mL ( $10^8/\text{L}$ ) of urine, although as many as one-third of females with symptomatic infection have less than  $10^5$  bacteria/mL ( $10^8/\text{L}$ ).

## TREATMENT

- **Goals of Treatment:** Eradicate the invading organisms, prevent or treat systemic consequences of infection, prevent recurrence of infection, and decrease the potential for collateral damage with excessively broad antimicrobial therapy.
- The management of a patient with a UTI includes initial evaluation, selection of an antibacterial agent and duration of therapy, and follow-up evaluation.
- The initial selection of an antimicrobial agent for the treatment of UTI is primarily based on the severity of the presenting signs and symptoms, the site of infection, and whether the infection is determined to be complicated or uncomplicated. Other considerations include antibiotic susceptibility, side-effect potential, cost, current antimicrobial exposure, and the comparative inconvenience of different therapies.

## PHARMACOLOGIC TREATMENT

- Eradication of bacteria from the urinary tract is directly related to the sensitivity of the organism and the achievable concentration of the antimicrobial agent in the urine.
- Management of UTIs is best accomplished by first categorizing the type of infection: acute uncomplicated cystitis, symptomatic abacteriuria, asymptomatic bacteriuria, complicated UTIs, recurrent infections, or prostatitis.
- Most *E. coli* remain susceptible to **trimethoprim-sulfamethoxazole**, although resistance is increasing and has been reported as high as 27%. In light of rising resistance and in order to decrease the overuse of broad-spectrum antimicrobials, agents such as **nitrofurantoin** and **fosfomycin** are considered first-line treatments along with trimethoprim-sulfamethoxazole in acute uncomplicated cystitis.
- **Table 48-1** lists the most common agents used to treat lower UTIs in adults, along with comments concerning their general use.
- **Table 48-2** presents an overview of various therapeutic options for outpatient therapy for UTI.
- **Table 48-3** describes empiric treatment regimens for specific clinical situations.

TABLE 48-1

### Commonly Used Antimicrobial Agents in the Treatment of UTIs

| Drug                          | Adverse Drug Reactions                | Monitoring Parameters                | Comments                                                                                                                                                                                                                             |
|-------------------------------|---------------------------------------|--------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Oral Therapy</b>           |                                       |                                      |                                                                                                                                                                                                                                      |
| Trimethoprim-sulfamethoxazole | Rash, Stevens-Johnson syndrome, renal | Serum creatinine, BUN, electrolytes, | Highly effective against most aerobic enteric bacteria except <i>P. aeruginosa</i> . High urinary tract tissue concentrations and urine concentrations are achieved, which may be important in complicated infection treatment. Also |

|                                      |                                                                                                           |                                         |                                                                                                                                                                                                                           |
|--------------------------------------|-----------------------------------------------------------------------------------------------------------|-----------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                      | failure, photosensitivity, hematologic (neutropenia, anemia, etc)                                         | signs of rash, and CBC                  | effective as prophylaxis for recurrent infections.                                                                                                                                                                        |
| Nitrofurantoin                       | GI intolerance, neuropathies, and pulmonary reactions                                                     | Baseline serum creatinine and BUN       | Effective as both a therapeutic and prophylactic agent in patients with recurrent UTIs. Main advantage is the lack of resistance even after long courses of therapy.                                                      |
| Fosfomycin trometamol                | Diarrhea, headache, and angioedema                                                                        | No routine tests recommended            | Single-dose therapy for uncomplicated infections, low levels of resistance, use with caution in patients with hepatic dysfunction. May also be used as step-down treatment                                                |
| Fluoroquinolones                     |                                                                                                           |                                         |                                                                                                                                                                                                                           |
| Ciprofloxacin<br>Levofloxacin        | Hypersensitivity, photosensitivity, GI symptoms, dizziness, confusion, and tendonitis (black box warning) | CBC, baseline serum creatinine, and BUN | Greater spectrum of activity, including <i>P. aeruginosa</i> . Effective for pyelonephritis and prostatitis. Avoid in pregnancy and children. Moxifloxacin should not be used owing to inadequate urinary concentrations. |
| Amoxicillin-clavulanate              | Hypersensitivity (rash, anaphylaxis), diarrhea, superinfections, and seizures                             | CBC, signs of rash, or hypersensitivity | Due to increasing <i>E. coli</i> resistance, amoxicillin-clavulanate is the preferred penicillin for uncomplicated cystitis.                                                                                              |
| Cephalosporins                       |                                                                                                           |                                         |                                                                                                                                                                                                                           |
| Cefaclor<br>Cefpodoxime proxetil     | Hypersensitivity (rash, anaphylaxis), diarrhea, superinfections, and seizures                             | CBC, signs of rash, or hypersensitivity | No major advantages over other agents for treating UTIs, and they are more expensive. Not active against enterococci.                                                                                                     |
| <b>Parenteral Therapy</b>            |                                                                                                           |                                         |                                                                                                                                                                                                                           |
| Aminoglycosides                      |                                                                                                           |                                         |                                                                                                                                                                                                                           |
| Gentamicin<br>Tobramycin<br>Amikacin | Ototoxicity, nephrotoxicity                                                                               | Serum creatinine and BUN, serum drug    | Renally excreted and achieve good concentrations in the urine. Amikacin generally is reserved for multidrug-resistant bacteria.                                                                                           |

|                                                                                                  |                                                                                                           |                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|--------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------|-----------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                                                  |                                                                                                           | concentrations, and individual pharmacokinetic monitoring |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <i>Penicillins</i>                                                                               |                                                                                                           |                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Ampicillin–sulbactam<br>Piperacillin–tazobactam                                                  | Hypersensitivity (rash, anaphylaxis), diarrhea, superinfections, and seizures                             | CBC, signs of rash, or hypersensitivity                   | Generally are equally effective for susceptible bacteria. The extended-spectrum penicillins are more active against <i>P. aeruginosa</i> and enterococci and often are preferred over cephalosporins. They are very useful in renally impaired patients or when an aminoglycoside is to be avoided.                                                                                                                                                                                     |
| <i>Cephalosporins</i>                                                                            |                                                                                                           |                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Ceftriaxone<br>Ceftazidime<br>Cefepime<br>Ceftolozane/tazobactam<br>Ceftazidime/avibactam        | Hypersensitivity (rash, anaphylaxis), diarrhea, superinfections, and seizures                             | CBC, signs of rash, or hypersensitivity                   | Second- and third-generation cephalosporins have a broad spectrum of activity against gram-negative bacteria, but are not active against enterococci and have limited activity against <i>P. aeruginosa</i> . Ceftazidime and cefepime are active against <i>P. aeruginosa</i> . They are useful for nosocomial infections and urosepsis due to susceptible pathogens.                                                                                                                  |
| <i>Carbapenems/monobactams</i>                                                                   |                                                                                                           |                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Imipenem–cilastatin<br>Meropenem<br>Meropenem/vaborbactam<br>Doripenem<br>Ertapenem<br>Aztreonam | Hypersensitivity (rash, anaphylaxis), diarrhea, superinfections, and seizures                             | CBC, signs of rash, or hypersensitivity                   | Carbapenems have a broad spectrum of activity, including gram-positive, gram-negative, and anaerobic bacteria. Imipenem, meropenem, and doripenem are active against <i>P. aeruginosa</i> and enterococci, but ertapenem is not. Aztreonam is a monobactam that is only active against gram-negative bacteria, including some strains of <i>P. aeruginosa</i> . Generally useful for nosocomial infections when aminoglycosides are to be avoided and in penicillin-sensitive patients. |
| <i>Fluoroquinolones</i>                                                                          |                                                                                                           |                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Ciprofloxacin<br>Levofloxacin                                                                    | Hypersensitivity, photosensitivity, GI symptoms, dizziness, confusion, and tendonitis (black box warning) | CBC, baseline serum creatinine, and BUN                   | Broad-spectrum activity against both gram-negative and gram-positive bacteria. They provide urine and high-tissue concentrations and are actively secreted in reduced renal function.                                                                                                                                                                                                                                                                                                   |

BUN, blood urea nitrogen; CBC, complete blood count; GI, gastrointestinal; UTIs, urinary tract infections.

TABLE 48-2

Overview of Outpatient Antimicrobial Therapy for Lower Tract Infections in Adults

| Indications                   | Antibiotic                               | Oral Dose        | Interval <sup>a</sup>        | Duration           |
|-------------------------------|------------------------------------------|------------------|------------------------------|--------------------|
| <b>Lower Tract Infections</b> |                                          |                  |                              |                    |
| Uncomplicated                 | Trimethoprim-sulfamethoxazole            | 1 DS tablet      | Twice a day                  | 3 days             |
|                               | Nitrofurantoin monohydrate               | 100 mg           | Twice a day                  | 5 days             |
|                               | Fosfomycin trometamol                    | 3 g              | Single dose                  | 1 day              |
|                               | Ciprofloxacin                            | 250 mg           | Twice a day                  | 3 days             |
|                               | Levofloxacin                             | 250 mg           | Once a day                   | 3 days             |
|                               | Amoxicillin-clavulanate<br>Pivmecillinam | 500 mg<br>400 mg | Every 8 hours<br>Twice a day | 5–7 days<br>3 days |
| Complicated                   | Trimethoprim-sulfamethoxazole            | 1 DS tablet      | Twice a day                  | 7–10 days          |
|                               | Ciprofloxacin                            | 250–500 mg       | Twice a day                  | 7–10 days          |
|                               | Levofloxacin                             | 250 mg           | Once a day                   | 10 days            |
|                               |                                          | 750 mg           | Once a day                   | 5 days             |
|                               | Amoxicillin-clavulanate                  | 500 mg           | Every 8 hours                | 7–10 days          |
|                               |                                          |                  |                              |                    |
| Recurrent infections          | Nitrofurantoin                           | 50 mg            | Once a day                   | 6 months           |
|                               | Trimethoprim-sulfamethoxazole            | 1/2 SS tablet    | Once a day                   | 6 months           |
| Acute pyelonephritis          | Trimethoprim-sulfamethoxazole            | 1 DS tablet      | Twice a day                  | 14 days            |
|                               | Ciprofloxacin                            | 500 mg           | Twice a day                  | 14 days            |
|                               |                                          | 1000 mg ER       | Once a day                   | 7 days             |
|                               | Levofloxacin                             | 250 mg           | Once a day                   | 10 days            |
|                               |                                          | 750 mg           | Once a day                   | 5 days             |
|                               | Amoxicillin-clavulanate                  | 500 mg           | Every 8 hours                | 14 days            |
|                               |                                          |                  |                              |                    |

DS, double strength; SS, single strength.

<sup>a</sup>Dosing intervals for normal renal function.

TABLE 48-3

Evidence-Based Empirical Treatment of UTIs and Prostatitis

| Diagnosis                    | Pathogens                                                                                                                  | Treatment Recommendation                                                                                                                                                                                                                                                                                                                                                              | Comments                                                                                                                                                                                                                                                                                                                                                                                             |
|------------------------------|----------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Acute uncomplicated cystitis | <i>E. coli</i> , <i>S. saprophyticus</i>                                                                                   | <ol style="list-style-type: none"> <li>1. Nitrofurantoin × 5 days (A,I)<sup>a</sup></li> <li>2. Trimethoprim-sulfamethoxazole × 3 days (A,I)<sup>a</sup></li> <li>3. Fosfomycin trometamol × 1 dose (A,I)<sup>a</sup></li> <li>4. Fluoroquinolone × 3 days (A,I)<sup>a</sup></li> <li>5. β-Lactams × 3–7 days (B,I)<sup>a</sup></li> <li>6. Pivmecillinam × 3–7 days (A,I)</li> </ol> | <p>Short-course therapy more effective than single dose</p> <p>Reserve fluoroquinolones as alternatives to development of resistance (A-III)<sup>a</sup></p> <p>β-Lactams as a group are not as effective in acute cystitis than trimethoprim-sulfamethoxazole or the fluoroquinolones, do not use amoxicillin or ampicillin<sup>a</sup></p> <p>Pivmecillinam not available in the United States</p> |
| Pregnancy                    | As above                                                                                                                   | <ol style="list-style-type: none"> <li>1. Amoxicillin-clavulanate × 7 days</li> <li>2. Cephalosporin × 7 days</li> <li>3. Trimethoprim-sulfamethoxazole × 7 days</li> </ol>                                                                                                                                                                                                           | Avoid trimethoprim-sulfamethoxazole during the third trimester                                                                                                                                                                                                                                                                                                                                       |
| Acute pyelonephritis         |                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                      |
| Uncomplicated                | <i>E. coli</i>                                                                                                             | <ol style="list-style-type: none"> <li>1. Fluoroquinolone × 7 days (A,I)<sup>a</sup></li> <li>2. Trimethoprim-sulfamethoxazole (if susceptible) × 14 days (A,I)<sup>a</sup></li> </ol>                                                                                                                                                                                                | Can be managed as outpatient                                                                                                                                                                                                                                                                                                                                                                         |
|                              | Gram-positive bacteria                                                                                                     | <ol style="list-style-type: none"> <li>1. Amoxicillin or amoxicillin-clavulanic acid × 14 days</li> </ol>                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                      |
| Complicated                  | <i>E. coli</i><br><i>Proteus mirabilis</i><br><i>K. pneumoniae</i><br><i>P. aeruginosa</i><br><i>Enterococcus faecalis</i> | <ol style="list-style-type: none"> <li>1. Quinolone × 14 days</li> <li>2. Extended-spectrum penicillin plus aminoglycoside</li> </ol>                                                                                                                                                                                                                                                 | <p>Severity of illness will determine duration of IV therapy; culture results should direct therapy</p> <p>Oral therapy may complete 14 days of therapy</p>                                                                                                                                                                                                                                          |

|             |                                                                                       |                                                                              |                                                                                                                           |
|-------------|---------------------------------------------------------------------------------------|------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------|
| Prostatitis | <i>E. coli</i><br><i>K. pneumoniae</i><br><i>Proteus</i> spp.<br><i>P. aeruginosa</i> | 1. Trimethoprim-sulfamethoxazole × 4–6 weeks<br>2. Fluoroquinolone 4–6 weeks | Acute prostatitis may require IV therapy initially<br>Chronic prostatitis may require longer treatment periods or surgery |
|-------------|---------------------------------------------------------------------------------------|------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------|

IV, intravenous; UTI, urinary tract infection.

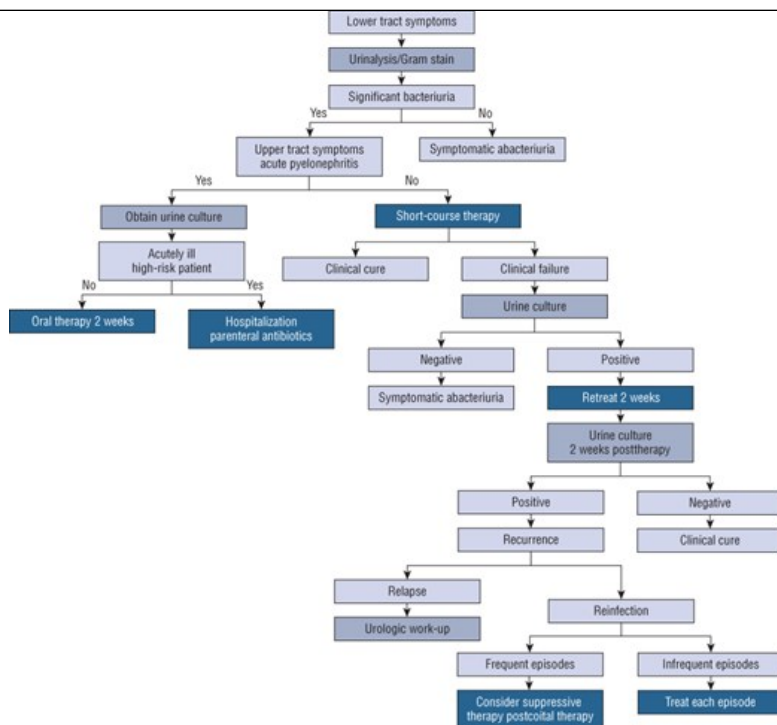
<sup>a</sup>Strength of recommendations: A, good evidence for; B, moderate evidence for; C, poor evidence for and against; D, moderate against; E, good evidence against. Quality of evidence: I, at least one proper randomized, controlled study; II, one well-designed clinical trial; III, evidence from opinions, clinical experience, and expert committees.

### Acute Uncomplicated Cystitis

- These infections are predominantly caused by *E. coli*, and antimicrobial therapy should be directed against this organism initially. Because the causative organisms and their susceptibilities are generally known, a cost-effective approach to management is recommended that includes a urinalysis and initiation of empiric therapy without a urine culture (Fig. 48-1).
- Short-course therapy (3-day therapy) with trimethoprim-sulfamethoxazole or a fluoroquinolone (eg, ciprofloxacin or levofloxacin, but not moxifloxacin) is superior to single-dose therapy for uncomplicated infection. Fluoroquinolones should be reserved for patients with suspected or possible pyelonephritis due to the collateral damage risk. Instead, a 3-day course of trimethoprim-sulfamethoxazole, a 5-day course of nitrofurantoin, or a one-time dose of fosfomycin should be considered as first-line therapy. In areas where there is more than 20% resistance of *E. coli* to trimethoprim-sulfamethoxazole, nitrofurantoin or fosfomycin should be utilized.

FIGURE 48-1

### Management of urinary tract infections in women.



Source: Terry L. Schwinghammer, Joseph T. DiPiro, Vicki L. Ellingrod, Lisa M. Holle, Cecily V. DiPiro: *DiPiro's Pharmacotherapy Handbook, 13th Edition*  
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## Complicated Urinary Tract Infections

### Acute Pyelonephritis

- The presentation of high-grade fever ( $>38.3^{\circ}\text{C}$  [ $100.9^{\circ}\text{F}$ ]) and severe flank pain should be treated as acute pyelonephritis, and aggressive management is warranted. Severely ill patients with pyelonephritis should be hospitalized and IV antibiotics administered initially. Milder cases may be managed with oral antibiotics in an outpatient setting.
- At the time of presentation, a Gram stain of the urine should be performed, along with urinalysis, culture, and sensitivity tests.
- In the mild to moderately symptomatic patient for whom oral therapy is considered, an effective agent should be administered for 7–14 days, depending on the agent used. Fluoroquinolones (**ciprofloxacin** or **levofloxacin**) orally for 7–10 days are the first-line choice in mild-to-moderate pyelonephritis. Other options include **trimethoprim-sulfamethoxazole** for 14 days. If a Gram stain reveals gram-positive cocci, *E. faecalis* should be considered and treatment must be directed against this pathogen (**ampicillin**).
- In the seriously ill patient, the traditional initial therapy is an IV fluoroquinolone, an aminoglycoside with or without **ampicillin**, or an extended-spectrum cephalosporin with or without an aminoglycoside and carbapenems.
- If the patient has been hospitalized in the last 6 months, has a urinary catheter, or is in a nursing home, the possibility of *P. aeruginosa* and enterococci infection, as well as multiple-resistant organisms, should be considered. In this setting, broad-spectrum coverage, such as an extended spectrum beta-lactam/beta-lactamase inhibitor or carbapenem, is recommended.
- Follow-up urine cultures should be obtained 2 weeks after the completion of therapy to ensure a satisfactory response and to detect possible relapse.

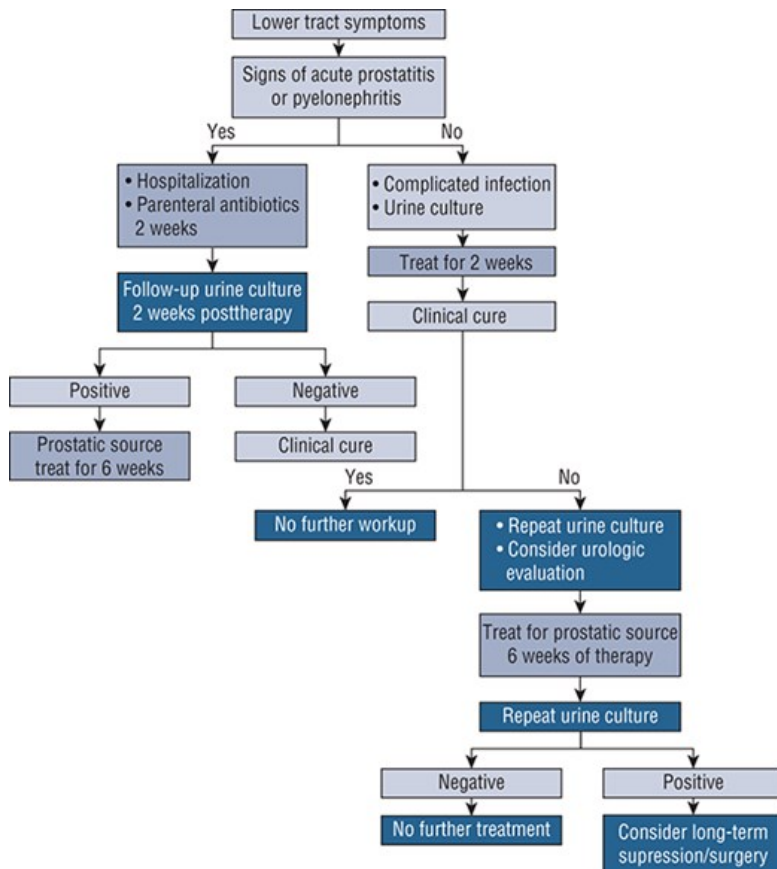
### Urinary Tract Infections in Men

- Therapy in men requires prolonged treatment (**Fig. 48-2**).
- A urine culture should be obtained before treatment, because the cause of infection in men is not as predictable as in females.

- If gram-negative bacteria are presumed, trimethoprim-sulfamethoxazole or a fluoroquinolone should be considered. Initial therapy is for 10–14 days. For recurrent infections in men, cure rates are much higher with a 6-week regimen of trimethoprim-sulfamethoxazole.

FIGURE 48-2

### Management of urinary tract infections in men.



Source: Terry L. Schwinghammer, Joseph T. DiPiro, Vicki L. Ellingrod, Lisa M. Holle, Cecily V. DiPiro: *DiPiro's Pharmacotherapy Handbook, 13<sup>th</sup> Edition*  
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### Recurrent Infections

- Recurrent episodes of UTI (reinfections and relapses) account for a significant portion of all UTIs. These patients are most commonly female and can be divided into two groups: those with fewer than two or three episodes per year and those who develop more frequent infections.
- In patients with infrequent infections (ie, fewer than three infections per year), each episode should be treated as a separately occurring infection. Short-course therapy should be used in symptomatic female patients with lower tract infection.
- In patients who have frequent symptomatic infections and no apparent precipitating event, long-term prophylactic antimicrobial therapy may be instituted (see [Table 48-2](#)). Therapy is generally given for 6 months, with urine cultures followed monthly.
- In females who experience symptomatic reinfections in association with sexual activity, voiding after intercourse may help prevent infection. Also, self-administered, single-dose prophylactic therapy with **trimethoprim-sulfamethoxazole** taken after intercourse significantly reduces the incidence of recurrent infection in these patients.
- Females who relapse after short-course therapy should receive a 2-week course of therapy. In patients who relapse after 2 weeks, therapy should be continued for another 2–4 weeks. If relapse occurs after 6 weeks of treatment, urologic examination should be performed, and therapy for 6

months or even longer may be considered.

## SPECIAL CONDITIONS

### URINARY TRACT INFECTION IN PREGNANCY

- In females with significant bacteriuria, symptomatic or asymptomatic treatment is recommended to avoid possible complications during the pregnancy. Therapy should consist of an agent with a relatively low adverse-effect potential (**cephalexin, amoxicillin, or amoxicillin/clavulanate**) administered for 4–7 days.
- **Tetracyclines** should be avoided because of teratogenic effects and sulfonamides should not be administered during the third trimester because of the possible development of kernicterus and hyperbilirubinemia. Also, the fluoroquinolones should not be given because of their potential to inhibit cartilage and bone development in the newborn.

### CATHETERIZED PATIENTS

- When bacteriuria occurs in asymptomatic, short-term catheterized patients (<30 days), the use of systemic antibiotic therapy should be withheld and the catheter removed as soon as possible. If the patient becomes symptomatic, the catheter should again be removed, and treatment as described for complicated infections should be started.
- In long-term catheterized patients, however, antibiotics only postpone the development of bacteriuria and lead to emergence of resistant organisms.

See [Chapter 144](#), *Urinary Tract Infections*, authored by Julianna M. Fernandez and Elizabeth A. Coyle, for a more detailed discussion of this topic.